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MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 3, 2016/2017

ECE3266 – DIGITAL AUDIO SIGNAL PROCESSING
(ME)

1st JUNE 2017
2:30 PM – 4:30 PM
(2 hours)

INSTRUCTION TO STUDENT

1. This question paper consists of 4 questions on 5 pages.
2. Attempt **ALL** the questions in this paper.
3. The total marks for this paper is 60. The marks allocated for each question is given. The marks are allocated based on the learning outcome of the subject and are therefore not evenly distributed.
4. Please write all your answers in the answer booklet provided. Clearly number your answers.

Question 1

- (a) Describe how we are able to determine the direction of sound. [2 marks]
- (b) As Luqman sat fishing in his little boat in the middle of a lake, a very fast speedboat came towards him. As the speedboat sped past, the driver continuously pressed his horn to alert Luqman of his presence.
- (i) In the context of Doppler effect, describe in detail what Luqman will hear when the speedboat is approaching and speeding away from him. [3 marks]
- (ii) As the sun begins to set, Luqman can hear his mother calling him home for dinner even though he was quite far away from the shore. What is this acoustic phenomenon called? Explain why he can hear her clearly. Use a diagram if necessary. [4 marks]
- (c) Figure 1 shows a rope that is fixed at one end. Some pulses are applied to the rope at the left end which travels towards to the right end of the rope. Describe what happens when the incident pulse reaches the boundary.



Figure 1

- [4 marks]
- (d) The Grand Hall at MMU is to be remodelled to create better acoustics for student performances, specially shows that involve musical instruments. Explain THREE (3) aspects that must be considered in order to achieve this. [3 marks]
- (e) The fundamental frequency of a violin's string was measured at 350 Hz. Calculate the second and fourth harmonic of the string. [2 marks]
- (f) Name the major components of the outer ear, middle ear and inner ear. [3 marks]

Continued...

Question 2

- (a) Explain the role of the velum in speech production. [2 marks]
- (b) The phonemes /s/ and /z/ are both classified as fricative sounds.
- (i) Explain the major characteristics of fricatives. Describe how the sound source is produced. [3 marks]
- (ii) If the position of the articulators is similar for both sounds, describe then what makes /s/ and /z/ different from each other. [3 marks]
- (c) Figure 2 is a spectrogram of a person saying “*I can see you*”.

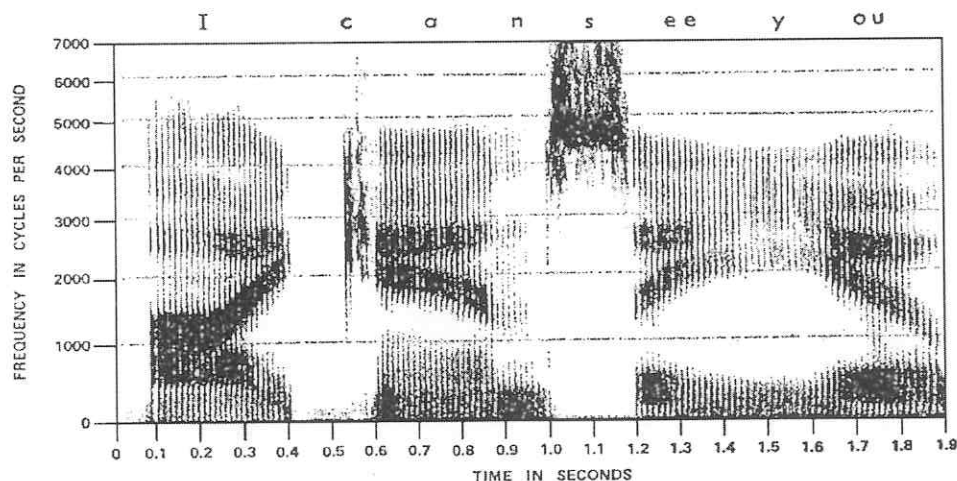


Figure 2

- (i) Give an estimate value of the third formant for the vowel /a/. [2 marks]
- (ii) What type of spectrogram is this? Explain how the spectrogram is derived. [4 marks]
- (iii) Explain why there is no spectral energy in the lower frequencies between 1.0 and 1.2 seconds. [4 marks]
- (d) If the vowel /ae/ (as in “air”) is produced with a constant cross-sectional area throughout the vocal tract, draw a model for the production of the vowel which follows the acoustic theory of speech production. Label the lips and glottis. [3 marks]

Continued...

Question 3

- (a) An analogue signal with a maximum frequency of 15500 Hz was sampled at 10 kHz. Determine if aliasing has occurred. Justify your answer. Suggest ONE (1) method to prevent aliasing. [3 marks]
- (b) State THREE (3) important dimensions of speech coders, and describe the desired characteristics of a speech coder with respect to the dimensions. [3 marks]
- (c) State the independent layers offered in Moving Picture Expert Group (MPEG) audio coding and describe them. [3 marks]
- (d) The toilet renovations in the FOE building exposed staff to the noise levels given in Table 1. Calculate the equivalent noise level (L_{eq}) over an 8-hour working period.

Table 1

dB(A)	Time (hours)
95	1.7
99	0.3
85	4
80	2

[3 marks]

Question 4

- (a) One of the uses of an Automatic Speech Recognition system (ASR) is to auto-generate captions on video in aide of the hearing impaired. However, some noticeable errors can be seen in the sentences. For example, when the actor was saying "*It's not easy to recognize speech*", the captions "*Its not easy to wreck a nice beach*" were generated by the system. Explain why these errors occur. [3 marks]
- (b) In light of the issue stated in Question 4(a), state SIX (6) important aspects that must be considered when developing an ASR system. [3 marks]

End of Questions

Appendix A

Effective Absorption Coefficients of Common Building Materials

Material	Frequency in Hz		
	125	500	2000
Acoustic paneling	0.16	0.50	0.80
Acoustic plaster	0.30	0.50	0.55
Brick wall, unpainted	0.02	0.03	0.05
Draperies			
Light	0.04	0.11	0.30
Heavy	0.10	0.50	0.82
Felt	0.13	0.56	0.65
Floor			
Concrete	0.01	0.02	0.02
Wood	0.06	0.06	0.06
Carpeted	0.11	0.37	0.27
Glass	0.04	0.05	0.05
Marble or glazed tile	0.01	0.01	0.02
Plaster	0.04	0.05	0.05
Rock wool	0.35	0.63	0.83
Wood paneling, pine	0.10	0.10	0.08